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DEPARTMENT OF AGRICULTURE

FOR THE WEST INDIES.

COCO-NUT CULTIVATION

—IN THE—

WEST INDIES.

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1911.

PREFACE.

Of recent years there has been much greater interest evinced in the cultivation of the coco-nut palm in the West Indies. This has been the outcome of two factors. The first is the effort that has been made to introduce the cultivation of more than one crop into the different islands, in order to avoid the evils involved in dependence upon one industry alone. The second is the considerable increase in the market value of the products derived from this palm, particularly in those of copra and oil. The large number of uses to which coco-nut oil can now be put makes it probable that, not only will these high prices be maintained for some time, but a further rise even may be expected, as the demand for coco-nut oil and the copra is in excess of the supply.

This increase of interest in coco-nut cultivation has naturally resulted in a desire to enlarge the area at present planted with these palms and, in consequence, a demand has arisen for information on general methods of creating and maintaining successful coco-nut plantations. It is with a view to meeting this demand that the following pages have been written.

There are many situations in the islands of the Lesser Antilles where the coco-nut could be grown to advantage. Such are the open, low-lying coastal land possessing a light porous soil and a moderate rainfall. These are at present often neglected and allowed to remain barren and unproductive. With the expenditure of a certain amount of capital, however, and with a reasonable output of labour, they might

be converted into successful and highly remunerative coco-nut plantations. Though this is undoubtedly the case, it must be borne in mind that coco-nuts will not prosper in such, or indeed in any situation, unless they receive adequate care and attention, particularly in respect to manuring and tillage.

In addition to information on the establishment and maintenance of a plantation, this pamphlet also contains an account of the pests and diseases of the coco-nut palm as at present known in the West Indies, and also a short outline of the preparation and use of the various commercial products to be obtained from this magnificent plant. A section dealing with insect pests has been prepared by H. A. Ballou, M. Sc., Entomologist on the Staff of this Department, while that dealing with diseases has been written by F. W. South, B.A. (Cantab.) the Mycologist, to whom the preparation of the rest of the pamphlet has also been entrusted.

It is hoped that the contents of this pamphlet will be of use to all those who are interested in the subject of coco-nut cultivation and the diversification of West Indian crops, and are desirous of establishing plantations for themselves.

Commissioner of Agriculture
for the West Indies.

July 14, 1911.

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COCO-NUT CULTIVATION IN THE WEST INDIES.

INTRODUCTION.

Although crops of many kinds are now grown in the various islands of the West Indies, it is a remarkable peculiarity that for many years no attempt has been made to cultivate the coco-nut on any large scale in most of the islands of the Lesser Antilles, with the exception of Trinidad. This palm may be found in every one of them, growing singly here and there, or in small more or less neglected groves by the seashore, but in the majority of cases, until very recently, no estates have been permanently established for its cultivation, nor have its products been utilized for any other than purely local purposes. In spite of this, the fact remains that there are numerous localities around the shores of almost all the smaller islands where nothing is grown at the present time, but where, with some care and attention, groves of coco-nuts might be established, and reasonable profits obtained. The palms could be planted in such situations, not with the object of displacing any existing cultivation, but in order to obtain from soil at present unremunerative a regular and reliable return. In addition to these coastal lands, there are, in certain of the islands, a few small areas of rich alluvial soil attended by other favourable circumstances, on which coco nut palms might reasonably be expected to yield profits higher than those obtained from any other crop.

2

HABITAT AND GENERAL REQUIREMENTS.

Climate.

The coco-nut palm is found practically throughout the whole of the tropical zone. It has been cultivated for many centuries in the East where, in the islands of the Pacific Ocean, its existence is almost essential to the life of the inhabitants; in fact, it is believed by some authorities that these were its original home. There is, however, a very reasonable possibility that it is, like all the other species of genus to which it belongs, a native of tropical America, although its manifold uses have never, until in comparatively recent years, been appreciated to the same extent in the West as they have been in the East. It thrives best in places where the mean temperature is from 75° to 85° F., and the mean annual rainfall is not below 50 inches. It can also prosper in drier situations, provided there is a steady flow of water through the soil, such as is occasioned by the drainage of fresh water finding its way to the sea, or by the influx and reflux of the tide. It is, however, quite unable to tolerate the presence of stagnant water round its roots. Its two essential requirements are, then, ample sunlight and a sufficiency of moisture. Its growth is also favoured by freely moving currents of air, especially sea-breezes, and these facts, together with its power of tolerating large quantities of salt in the soil, have led to the belief that it can only prosper on sea-beaches or in places near the sea.

This is, however, not the case, for it flourishes in Ceylon on alluvial soil at some distance from the coast, and may be found in some countries as many as 300 miles inland. Its extreme ranges of rainfall and temperature conditions are much larger than those indicated above, but the figures given are those representing the most suitable con-

ditions, and as they also represent those of most situations in the West Indies, the others need not be considered in this Pamphlet.

The coco nut can be grown successfully up to an altitude of 2,000 feet, provided that the temperature requirements are fiulfilled; but it does not flourish on steep slopes or in too shaded and sheltered situations. Consequently, in the West Indies, it may be expected to thrive best on the lowlands round the coast, though it could probably also be grown to advantage in open and well drained valleys further inland and at a higher elevation.

Soil.

The best soil for the cultivation of coco-nuts is an alluvial loam, such as is found on the banks of rivers that overflow from time to time. On this, the trees will give large returns. Light, deep, sandy loams overlying coral or any porous substratum are also suitable. It must be remembered, however, that the plant depends very greatly on the fertility of the soil and requires a good supply of humus; consequently it will not prosper on pure sand alone, unless quantities of manure and humus are repeatedly supplied to it. Heavy clay soils, and all those with an impermeable substratum, which are likely to contain stagnant water, should be carefully avoided, as should also very shallow soils.

Botanical Description.

The coco-nut palm has a simple, unbranched trunk which may attain a height of from 70 to 80 feet, and a diameter of 12 to 18 inches. It is marked along its entire length by the scars of the fallen leaves. The stem is surmounted by a cluster of from twenty to thirty leaves, with the youngest in the centre. Each is composed of a basal portion or petiole which sheathes the bases of the younger leaves and the

growing point, and of an expanded portion consisting of a central stalk bearing numerous long narrow leaflets at right angles on either side. A full-grown leaf is about 17 feet in length, and from 4 feet 6 inches to 6 feet 6 inches in width The older leaves fall every year, and give rise to the prominent scars mentioned above.

The roots of the coco-nut palm arise in very large numbers from the portion of the stem below ground and spread out laterally in all directions, while, as in all monocotyledons, there is no tap root. The roots are red in colour, about as thick as a man's finger near their origin, and may attain a length of as much as 50 feet. Around the trunk of the tree they form an almost compact mass some few feet thick, while further out they become separated from one another. Some of them penetrate for a considerable depth into the soil, but the majority occur within a foot or two of the surface, and the plant must consequently be regarded as a surface feeder. The young, active ends of the primary roots, and the young portions of the secondary roots arising from them, are found at some distance from the trees. This is a point to be borne in mind when considering the application of manures.

The flowers are of two kinds, male and female. Both kinds are borne on the same stalk, the male at the upper end and the female below. Several such stalks are formed as branches of a central axis which itself arises in the angle between the main stem and one of the older leaves. The whole system, consisting of central axis, and lateral branches bearing the flowers, is surrounded when young by a large green leaf-like wrapper known as a spathe ; this unfolds as the flowers open.

The male flowers are sessile upon the branch bearing them. Each consists of three, small, narrow sepals, three wider, longer petals, yellowish in colour, six stamens and

FIG. 1. INFLORESCENCE OF THE COCO-NUT PALM.

often the rudiments of an ovary consisting of a three- or four-branched stigma. Viewed from below they are yellowish in colour. The female flowers are either sessile or furnished with a short stalk and are much larger than the male flowers.

Each consists of three, wide, greenish sepals, enfolding three wide petals, and an ovary more or less ovoid in shape containing three compartments each with one ovule; two of the latter usually abort, so that only one embryo is formed. The receptive surface for the pollen takes the form of three, somewhat small, recurved, triangular projections borne on the pointed end of the ovary, and so placed that their bases occupy the sides of a triangle, while the stigmatic surfaces face inwards. The female flowers, viewed from below, are greenish in colour.

The fruit is more or less ovoid, its exact shape depending on the variety of nut as also does the size, which often surpasses that of a man's head.

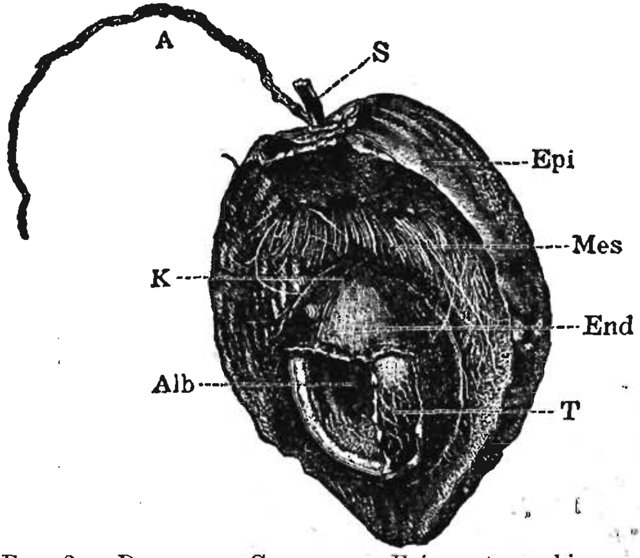

FIG. 2. DISSECTED COCO-NUT, Epi, outer skin, or epidermis, Mes, husk; End, shell; K, portion of original carpels; Alb, kernel; T, skin of kernel.

Beneath the smooth outer skin (Epi, in Fig. 2) is a fibrous covering, or husk, which may be as much as 2 inches thick, though this varies according to the variety. (Mes, in Fig 2.) Inside this is the nut as known in commerce. It has a very hard shell (End, in Fig. 2) with three more or less prominent longitudinal ridges and three well marked hollows at the base corresponding to the three original carpels. (K, in Fig. 2.) Inside the shell is a hollow white kernel (Alb, in Fig. 2) containing much oil. It varies considerably in thickness, according to the age of the nut and the variety of the palm. When the nut is young, the kernel is very thin and jelly-like; but as the fruit matures, it grows thicker and harder by absorbing the liquid contained in the central cavity of the nut. The young germ or embryo is buried in the kernel at the basal end, near one of the three hollows in the shell referred to above. Young nuts are almost completely filled with liquid, but as they grow older this is absorbed, until when they are ripe only about two-thirds of the cavity is filled.

Varieties.

A very large number of varieties is recognized in different parts of the world, and in many cases these have been definitely described. Very little is, however, known with respect to those occurring in the West Indies, so that at present nothing can be said on this point, though it is probable that careful observations would reveal the presence of at least two or three types among the coco nut palms at present growing in most of the islands of the Lesser Antilles.

ESTABLISHMENT OF A COCO-NUT PLANTATION.

Seed Selection. The first consideration in commencing to plant an estate with coco-nuts is that of obtaining seed. Almost any nut, when properly treated, will germinate and give a plant, but in the case of a permanent cultivation which is to occupy the ground for many years, it is essential that the trees should be strong and vigorous from

the start, and should be chosen from good varieties only. Consequently the greatest care must be exercised in selecting the seed, and in treating it when it has been selected, so that a strong uniform growth is obtained.

Nuts for planting should be obtained from carefully selected trees. These should be healthy and vigorous, about twenty-five years old, and known to produce a good crop of medium-sized nuts of good quality. The trees should, as far as possible, be growing in a district whose general conditions of soil and climate are similar to those of the district to be planted.

When the trees have been selected, the nuts also must be carefully chosen. They should be of medium size, not elongated, with a thin husk and a thick kernel. The thickness of the husk may be tested by inserting a knife until it reaches the shell. Large nuts often have a very thick husk and a thin kernel, which is not desirable, while a small crop of large nuts is not as remunerative as a large crop of medium-sized nuts. The seed nuts must have ripened on the tree and must be exactly ripe. The state of the nut may be tested by shaking it. If it is unripe and consequently still full of liquid, it will give a dull heavy sound; when ripe and only about two-thirds full, it gives a sharp, clear sound which is easily distinguished from the first after a little practice. Nuts that are to be used for seed should not be thrown down from the tree but should be carefully lowered, and care should be exercised not to damage them in any way. In some cases the nuts, even when ripe, contain a large quantity of water, and it is necessary to allow them to dry in the shade for a few days before planting. This drying must not be permitted to take place in full sunlight as then the kernel may be partly cooked and the germinating power lessened.

NURSERIES. The nuts, after selection, must be planted in carefully prepared nurseries. For this purpose a

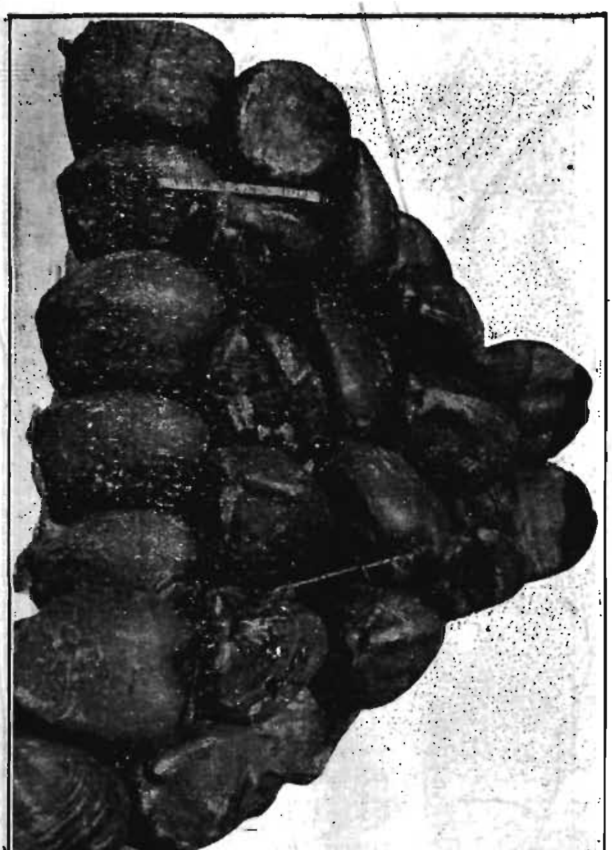

FIG. 3. HEAP OF NUTS SELECTED FOR SEED. (DOMINICA.)

piece of flat, well drained land with a good light soil should be chosen, where it can be kept under constant observation, not too far from the field to be planted,

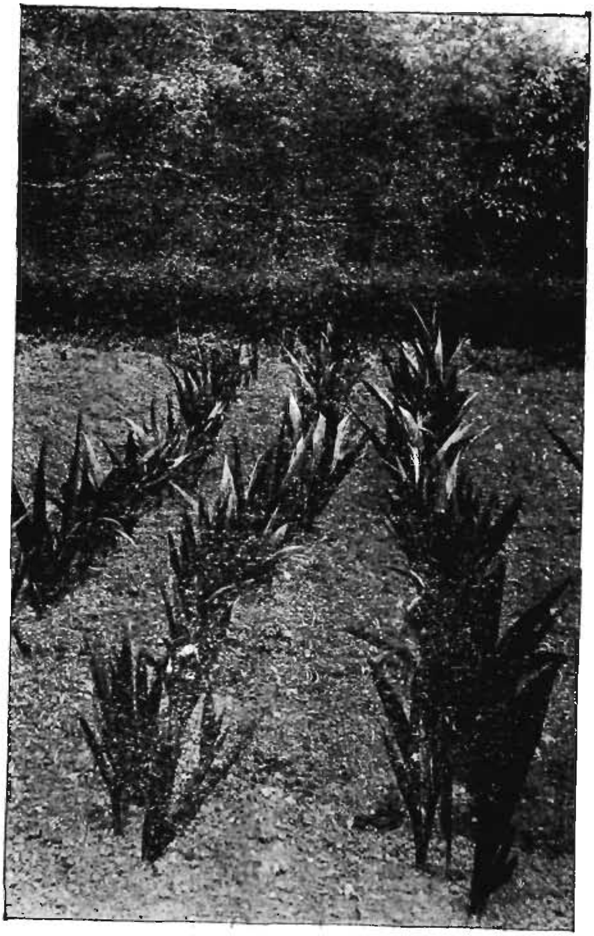

Fig. 4. Coco-nut Nursery. (Antigua.)

and with good facilities for obtaining water for irrigation purposes. It is not altogether disadvantageous if the spot chosen is shaded somewhat by trees, though this is not essential. The soil of the nursery should be well forked to a depth of about 18 inches, thoroughly pulverized, and all large stones and roots should be removed. It should then be made up into beds from 3 to 4 feet wide, with narrow paths between them. In places where the soil is liable to become too damp, the beds should be raised a little above the level of the surrounding land; on well-drained soils this is unnecessary. Trenches 6 inches deep must next be dug in the beds and the nuts must be placed in them at a distance of 1 foot apart, either horizontally or with the pointed end somewhat raised; they should not be planted in a vertical position. The soil that has been dug out of the trenches is then replaced until the nuts are covered to such a depth that only about a quarter of the upper part of each projects. The whole bed must then be covered to a depth of 6 inches with straw, grass, or cane trash. The nuts should be watered from time to time, in dry weather.

It is advisable to plant about 50 per cent. more nuts than are actually required, in order to make up for those that fail to germinate or have to be discarded on account of their having produced weakly plants. Germination lasts, on an average, from three to four months; those nuts which, when planted soon after picking, do not germinate before five or six months have elapsed are likely to give poor seedlings. The young plants must be left in the nursery until they are about a year old, when they are ready to be planted out.

Preparation of the Land for Planting. The land in which the young plants are to be put should be carefully cleared of bush during the dry season. The bush should be spread as a mulch or be lightly buried. The land must then be lined and holed. The former operation should be carefully conducted, as a well arranged plantation has a much better

FIG. 5. GERMINATING COCO-NUT.

appearance, and is more easily dealt with. than one carelessly lined. On average soils, the holes should be not less than 25 feet apart from centre to centre, each way, which gives sixty-nine trees to the acre; on rich soils they should be dug at distances of 30 feet, or even 35 feet, giving forty-eight or thirty-five trees to the acre. The holes are best arranged rather in triangles than in squares, that is in such a way that those in any one row are opposite the centres of the spaces between those of the two adjoining rows. The holes themselves must be dug 3 feet square and 3 feet deep. They should be left open for some time before planting. When the plants are to be placed in them, the soil taken from the hole should be mixed with well rotted manure or leaf mould and the hole filled in with this mixture to a depth of 18 inches. A plan found successful in Nevis is to line the bottom of the hole with fine megass to a depth of 18 inches, and to place soil on the top of that.

Planting Out. The young plants must be carefully removed from the nursery at the commencement of the rainy season. They should be taken up with as little injury to their roots as possible, while any broken roots should be cut off close to the nut by means of a sharp knife. The young plants should be conveyed quickly and carefully to the field, and at once planted in the prepared soil at the bottom of the holes. This should be done in such a way that the surface of the nut is just covered by the soil in the hole, while it is not less than 15 inches below the level of the general surface of the field. If possible, the plants should be watered when the operation of planting is completed, particularly if the weather is dry. Moreover, if by mischance rain should not fall during the first three weeks after planting, the palms should be watered every three or four days.

SUBSEQUENT TREATMENT OF PLANTS.

Once the young trees have been planted, there are three matters which must receive careful attention. In the first place, any trees which die must be promptly replaced. For this purpose it is advisable to make use of any healthy plants which may be left over in the original nursery, as they will be of the same age as those already in the field, and, in consequence, a more uniform growth is likely to be obtained. Uniformity in this respect is so desirable that it may even be found remunerative to remove any weakly young plants from the field at the end of the first year and to replace them by others from the original nursery.

The second point is that a space some 6 or 8 feet in diameter round the roots of the trees must be kept free from weeds, preferably by cutlassing. The diameter of this space must be increased as the tree grows. Care must be taken not to injure the trees in conducting this operation.

The third point relates to the question of drainage. If it is found that there is any tendency for water to accumulate in the soil, drains must promptly be opened. The number and depth of these will depend entirely on the nature of the soil, and must be determined separately in each special case. The point to be borne in mind, however, is that coco-nuts cannot and will not tolerate the presence of stagnant water in the soil, though they require all the moving water that they can obtain.

Provided that these three points receive the necessary attention, the general treatment of the plantation in other respects during the first four years may follow either of two different lines. It should be borne in mind that the palms will not cover the ground sufficiently to prevent the growth of bush until the end of the fourth year, and this will take place to such an extent, particularly in damp localities, that

the young trees are in danger of being killed. On the other hand, this exposed soil may be made to produce crops of various kinds, though these will remove some of the food in the soil. To offset this, it should be remembered that the coco-nut requires manure and a soil in a good state of tilth, and that the period which must elapse before it comes into bearing will depend on attention to these two points. The alternative courses, therefore, may be outlined as follows :—

THE FIRST COURSE. According to this, the trees receive the most careful treatment and no return whatever is expected until they begin to produce crops. The land should be cutlassed all over, as often as the growth of bush makes this operation necessary, the bush being left to dry and form a surface mulch. At the end of the first year and immediately after one of the occasions upon which the bush has been cutlassed, the soil should be forked over lightly to within a distance of 3 feet around the plants and the bush buried. Following on this, the soil may again be allowed to produce bush, or may be planted with a leguminous green dressing. Plants suitable for this purpose are Java crotalaria (*Crotalaria striata*), woolly pyrol (*Phaseolus Mungo*), Lima bean (*Phaseolus lunatus*), castor oil plant (*Ricinus communis*), ground nut (*Arachis hypogaea*), sword bean (*Canavalia gladiata*), horse bean (*Canavalia ensiformis*), possibly *Tephrosia candida* and *T. purpurea*, and broom corn (*Andropogon sorghum*, var. *technicus*). (See *Agricultural News*, Vols. IX, pp. 37 and 341; X, pp. 91 and 245; and the Annual Reports of the Botanic Stations in Antigua and Dominica for 1909-10, pp. 22 and 38, respectively.) Some of these may be made to give a return by way of crop, while the vegetative parts are turned into the soil. Generally speaking, however, the best plants to use are legumes, that is any in the above list except the castor oil plant or broom corn; they should be cutlassed just before they commence to flower, and eithe[r] ... [-e or be] lightly forked i... [par]ticularly

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desirable on account of their power of making use of the nitrogen of the atmosphere, so that not only is all the material taken from the soil returned to it, with the addition of a large supply of humus, but also in this instance a large quantity of nitrogen is added. Thus green dressings of this nature serve as a very valuable manure for coco-nuts since they add humus, an ingredient in which sandy soils are often deficient, and also increase the available nitrogen supply, while in the end no mineral salts are taken from the soil, the only thing removed being water.

During subsequent years the bush should be kept cutlassed, and at intervals of two or three years the land should be forked.

As the trees grow older, a dressing of pen manure or of artificial manures, if pen manure is unobtainable, should be lightly stirred in near the extremities of their roots, that is at a radius of some 6 to 8 feet, or more, from the trunk. By following this course, valuable supplies of nitrogen and humus are added to the soil while nothing is taken out; moreover the presence of humus also increases its water content by augmenting its power of retaining moisture.

THE SECOND COURSE. This allows of obtaining some return from the land during the first four years of the growth of the coco-nuts. Although by this means certain mineral salts are removed from the soil, yet humus may be returned, and the tillage operations necessary for the secondary crop are of service in keeping the soil in good tilth for the coco-nut roots when they shall eventually have spread into it. The system is to plant a crop such as cotton, bananas, cassava, sweet potato, Indian corn, Guinea corn, broom corn, or ground nuts between the lines of coco-nuts, leaving sufficient space around each tree to prevent damage. This may be repeated for three years. The bush or vines from the plants should be buried in the soil after the crop has been

reaped, while in the case of cotton, it would be found advisable either to grow one of the green leguminous dressings recorded above, or to add manure in some form, before planting cotton again in the second year. Ground nuts, as has been indicated, form a most useful crop for planting among coco-nuts, for they both yield some return and serve as a green dressing. In the case of bananas, the stems should be chopped up with a cutlass, once they have fruited; the pieces of stem form a good mulch, while suckers remain to give a further yield. The plants may be killed, when the coco-nuts are four years old, by cutting down the suckers as they appear. Cotton cannot be grown successfully for more than two years. If any crop is planted in the third year, it should be one of the others mentioned above.

After the fourth year, the treatment must depend on circumstances, but the points to be remembered are that the plants must have plenty of manure supplied as a green dressing, as pen manure, or as artificial manure, at intervals of from one to two years; and that the soil must be kept in good tilth, which may be attained by lightly forking in the manures when they are applied. As the trees come into bearing, they will require large quantities of potash and phosphorus, as these elements enter largely into the composition of the fruits. They may be supplied as sulphate of potash and kainit for potash, and as superphosphate, basic phosphate or bone meal for phosphorus. It should also be remembered that all fallen leaves and coco nut husks, where the latter are not used commercially, form a valuable addition to the soil, and should be left on the plantation and turned in from time to time, along with the other fertilizing materials.

The importance of manure and efficient tillage on a coconut estate cannot be unduly emphasized. Attention to these points will ensure that the trees come into bearing early, give

good yields, and are maintained in a good state of health, which will greatly assist in keeping them free from fungoid diseases and insect pests.

Harvesting. The nuts are best picked by hand. For this purpose boys are paid to climb the trees and pick all the ripe nuts. Care must be taken to prevent them from gathering those that are not ripe. Nuts may be picked once every three months, or once every six months, or even once a year. Though the more frequent gathering is preferable, it is sometimes difficult to obtain the necessary labour. Any ripe nuts which may be overlooked will fall from the trees, and should be collected subsequently.

YIELD.

Periods of Bearing. The trees may begin to produce nuts as early as the end of the fourth year; usually, however, they do not do so until the sixth or eighth year; while no crop of any great importance can generally be expected before the ninth to the twelfth year after planting. The length of this period depends very largely on the treatment which the trees receive while young, as well as on the fertility of the soil and the available supply of moisture. Subsequently, the crop increases steadily, until the twentieth or twenty-fifth year, when it reaches a maximum, and continues more or less the same until the tree is from fifty to seventy years old. After that age, the number of nuts produced by a coco nut palm gradually diminishes, though crops of some size are borne until the tree is eighty or one hundred years old. In Ceylon, palms older than this, even, have been known to give useful yields.

Crop Produced. Five or six separate fruit-bearing flower branches usually occur on a coco nut palm at one time, and each may carry as many as ten nuts; consequently, a mature tree always carries ripe nuts. The annual crop varies very

largely, according to the fertility of the soil, and even more in relation to the amount of manure, tillage, and general care bestowed upon the trees. A reasonable return throughout the whole of an estate would be from 50 to 75 nuts per tree, per annum. On a fertile and well-tended estate this might rise to as many as 100 nuts per tree, per annum; while individual trees have been known to give 200 and more medium sized nuts in a year. As already stated, everything

FIG. 8. COCO-NUT PALM IN FULL BEARING. (DOMINICA.)

depends upon the amount of care and attention which the trees receive. It is too frequently the custom in the West Indies to plant trees, without care, on a soil consisting of almost pure sand, and then to leave them untended. The natural result is that the trees are sickly, yield practically no crop, and eventually die, although, with very little expenditure of time and money, they could have been induced to give satisfactory returns.

PESTS AND DISEASES.

INSECT PESTS.

Coco-nuts, in common with other plants, are liable to be attacked by insects, which sometimes cause a considerable amount of injury. This can often be prevented by a knowledge of the appearance and habits of the insects, and of the remedies to be employed. The insects themselves may be divided into three classes: sucking insects, which live on the juice of the plant and include scale insects and white fly; biting insects such as leaf-eating caterpillars; and boring insects.

SUCKING INSECTS. One of the most common of the scale insects on the coco-nut palm is the Bourbon aspidiotus

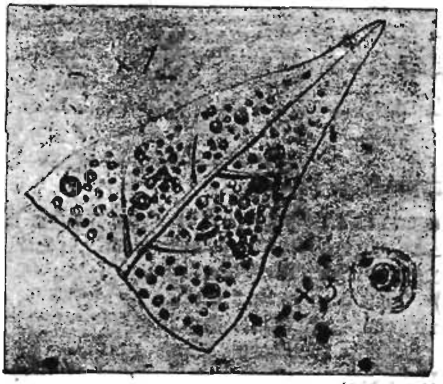

FIG. 9. THE BOURBON ASPIDIOTUS.

(*Aspidiotus destructor*—Fig 9.) This occurs on the leaves, where large numbers of individuals frequently are closely packed together, thus presenting the appearance of a scurfy

or scaly layer. Separate insects are not very conspicuous, but masses of them are easily seen. The scale itself is flat, whitish, thin and papery, with a pale-yellow central spot. It often occurs on the first leaves of young plants, turning them yellow; older leaves are also affected and, as in the case of the younger ones, the attacked areas are at first yellow, but they dry out subsequently, so that dead patches are formed. Even when the first leaves of the young plant are attacked, the pinnate or typical coco-nut leaves subsequently developed often remain quite free, as the plants seem to outgrow the attack of the scale.

The coco-nut snow scale (*Diaspis boisduvalii*) also occurs on the leaves, generally in small colonies, the position of which is indicated by yellowish discoloured areas. (Fig. 10.) The female insects are flattened and pear-shaped, while their colour is similar to that of the leaf, which renders them, therefore, very inconspicuous. The male scales are white in colour, oblong in shape, and have three distinct longitudinal ridges. The presence of small particles of wax scattered through the group increases the whiteness of the whole.

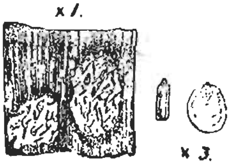

Fig. 10. The Coco-nut Snow Scale.

The coco-nut mealy-bug (*Pseudococcus nipae*) is a small, round insect, covered with yellowish wax, of which short, thick processes project from the sides. (Fig. 11.) This also occurs on the leaves of the coco-nut, sometimes in sufficient numbers to cause serious injury to the trees.

Fig. 11. The Coco-nut Mealy-Bug.

The glassy star scale (*Vinsonia stellifera*) is a very striking object. (Fig. 12.) The reddish-brown insect shows through its covering of white, glassy wax, which projects in radiating points to form the

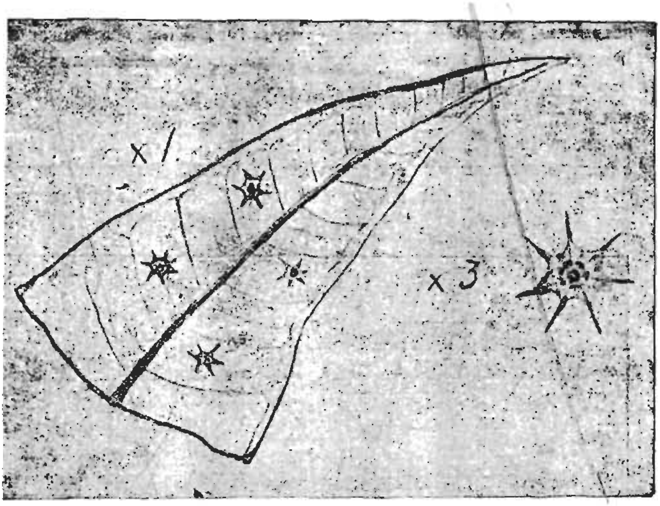

FIG. 12. THE GLASSY STAR SCALE.

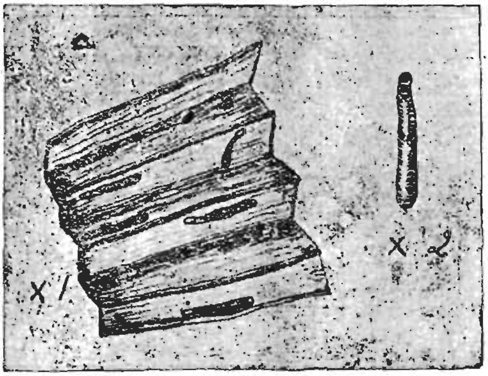

FIG. 13. THE BLACK LINE SCALE.

star from which the scale takes its name. This is not likely to become a serious pest, but it sometimes occurs in fair numbers.

The black line scale (*Ischnaspis longirostris*) is a long, narrow, black insect, resembling a black line in its appearance, as is suggested by its name. (Fig. 13.) It is a very common pest on palms of many kinds, but on coco-nuts does not often occur in sufficient numbers to be of any great importance; usually it lives on the leaves, but it is found also on the fruit.

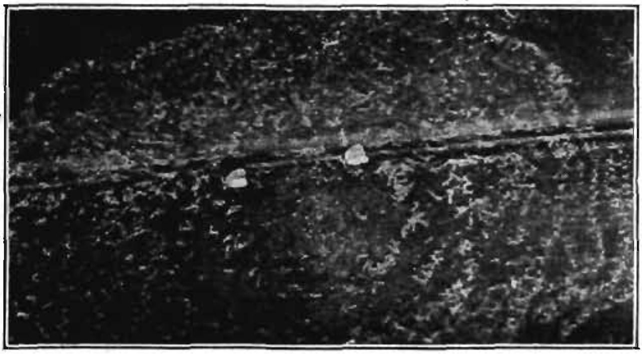

FIG. 14. COCO-NUT WHITE FLY. (ENLARGED.)

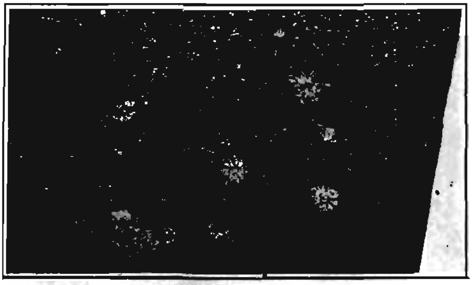

FIG. 14a. COCO-NUT WHITE FLY. (FURTHER ENLARGED.)

White fly (*Aleyrodicus cocois*) is often a serious pest. (Figs. 14 and 15.) It occurs in its several stages on the under side of the leaves. The adults are winged, but the immature stages of the insect are scale-like in appearance, and certain of them possess radiating wavy pencils of wax. The groups of these flies are usually covered with loose particles of wax, which make them easily distinguishable from the colonies of scale insects.

Scale insects and white fly may attack young coco-nuts, either in the nursery or in the field. If plants in the nursery are attacked, they should receive an application of some insecticide, in order that they may be rendered free from these pests before they are transplanted into the field. The Bourbon aspidiotus, the coco-nut snow scale, the coco-nut mealy-bug and the white fly may all be satisfactorily controlled by means of an oily or soapy wash, such as kerosene emulsion or whale oil soap; while the glassy star scale and the black line scale should receive an application of one of the rosin mixtures. If several different insects appear on the same plant, a wash such as rosin compound and whale oil soap may suitably be employed for their control.

INSECTICIDES. The washes just referred to may be prepared as follows :—

Whale-oil Soap.—Dissolve 1 lb. of whale-oil soap in 1 or 2 gallons of warm water.

Kerosene Emulsion.—Dissolve ½-lb. of hard soap in 1 gallon of boiling water. Add 2 gallons of kerosene to the hot liquid and immediately churn with a syringe or force pump, till the mixture becomes creamy and all the oil is thoroughly combined with the soap solution. Properly made emulsion will not show any free oil on the surface, even after standing two or three days. This is the stock solution. Make up to 33 gallons. Use only rain-water or soft water (i e , water without lime.)

Rosin Wash.—Mix 20 lb. of rosin, 3½ lb. of 98 per cent. caustic soda, and 3 pints of fish oil. The rosin and the caustic soda must be pounded before mixing. Cover this with about 2 inches of water, and boil. When the liquid is clear, *slowly* add water, still boiling the mixture, till the whole is made up to 15 gallons. This is the stock solution and can be made up to 100 gallons when cold, using only rain-water or soft water.

Rosin Compound.—Mix 4 lb. of powdered rosin, 3 lb. of powdered washing soda, and 1 gallon of water. Boil, and when all is dissolved, *slowly* make up to 5 gallons Boil the mixture till it becomes of a clear brown colour. This is the stock solution. Make this up to 30 gallons.

Rosin and Whale-oil Soap Compound.—This is composed as follows:—

Rosin	4 lb.
Washing soda	3 ,,
Whale-oil soap	10 ,,

With the rosin and soda make 4 gallons of rosin compound stock solution as above. Stir the whale oil soap in 5 gallons of hot water; mix the two while hot. This is the stock solution. To every gallon add 4 gallons of water. An alternative method is to make the rosin compound stock solution. For use, mix 1 gallon with 10 gallons of water and stir in 2½ lb. of whale oil soap. Every 45 gallons of wash should contain the above ingredients, however mixed.

Whale-oil Soap and Kerosene Emulsion.—The ingredients are:—

Whale-oil soap	10 lb.
Kerosene oil	12 pints
Water	20 ,,

The whale-oil soap should be boiled in water until it is thoroughly dissolved, and the kerosene churned in to form

an emulsion, as in the case of the kerosene emulsion described above.

This is the stock solution, and is sufficient to make 25 gallons of spray mixture, using 1 pint of stock solution to 4 pints of water. It might be found, under certain circumstances, that a more dilute mixture would be useful, and trials might be made of different strengths down to 1 pint of stock solution to 8 pints of water.

APPLICATION OF INSECTICIDES. These washes are usually applied by means of a spray pump or of a garden syringe, but young plants in the nursery may be treated by dipping them into a tub or trough of suitable size, or by washing them with the insecticides. Whichever of these two methods is employed, the wash should be carefully rubbed over the entire surface of the leaf with a piece of sponge or a bit of soft cloth. When the liquid is applied as a spray, the force with which it strikes the surface of the leaves enables it to penetrate the waxy secretion covering the insect, but when dipping or washing is resorted to, it becomes necessary to assist the penetration of the liquid in the manner indicated.

If young trees in the field are attacked by these insects to such an extent as to render it desirable to apply an insecticide, it will probably be found advantageous to use a knapsack or a barrel spraying machine, while the latter would also be useful for spraying older trees.

The Success Knapsack Sprayer (Fig. 15) is a useful type of machine in which continuous pumping is required while spraying. The Auto spray (Fig. 16), on the other hand, is a type of sprayer in which the pressure is produced by means of the pump before actual spraying is begun; the contents of the tank are forced out through the nozzle by the expansion of compressed air. The barrel sprayer is a machine of larger capacity, which may be mounted on a truck or carried on a

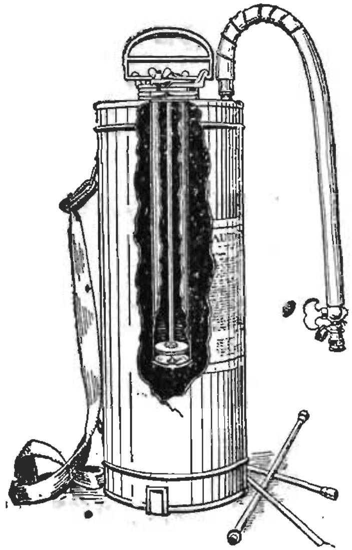

FIG. 16. THE AUTO-SPRAY.

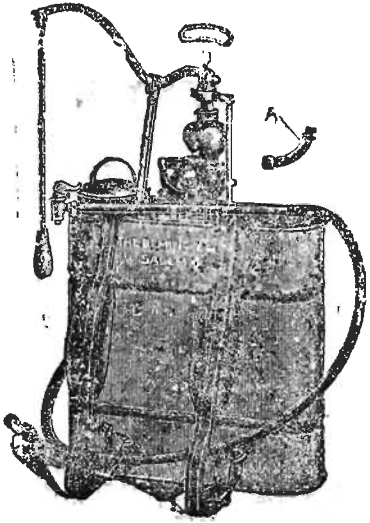

FIG. 15. SUCCESS KNAPSACK SPRAYER.

cart. This type of instrument can be supplied with two or more lines of india-rubber hose, and these greatly increase the scope and quantity of the work which can be done.

When conducting spraying operations, a question of some importance is that of the kind of nozzle to be employed. In applying insecticides for the control of scale insects, the nozzle used should be such as to produce a very fine mist-like spray, which at the same time should be ejected with a considerable amount of force. Such a spray will thoroughly wet the surface exposed to it, and will penetrate the fine crevices, minute spaces between epidermal hairs, or the fine layer of wax any or all of which are often found on leaves, especially those of palm trees. In consequence of this, it is much more effective than a coarser spray or a solid stream of liquid.

The Vermorel type of nozzle produces a very fine spray, and is suitable for the application of insecticides which are unlikely to contain any particles of solid matter. The Bordeaux nozzle (Fig. 17, No. 1) is adjustable, and may throw solid streams of liquid or a fairly fine spray. This latter serves for the application of any wash, similar to Bordeaux mixture, which might cause clogging of the nozzle, and is also of use when it is required to throw a stream to a distance. In general, the nozzle should be fixed to the end of a piece of gas pipe so that the distance between the nozzle and the surface to be sprayed may be rendered as short as possible.

It may be mentioned that coco-nuts that are kept in a vigorous state of growth by attention to questions such as drainage and manuring will probably not often require treatment for the control of scale insects. When, however, the leaves on older coco-nut trees are badly attacked, they should be cut and ultimately burned. Previously, how ever, they should be gathered into heaps after cutting, and should be left for a week or two in order that any

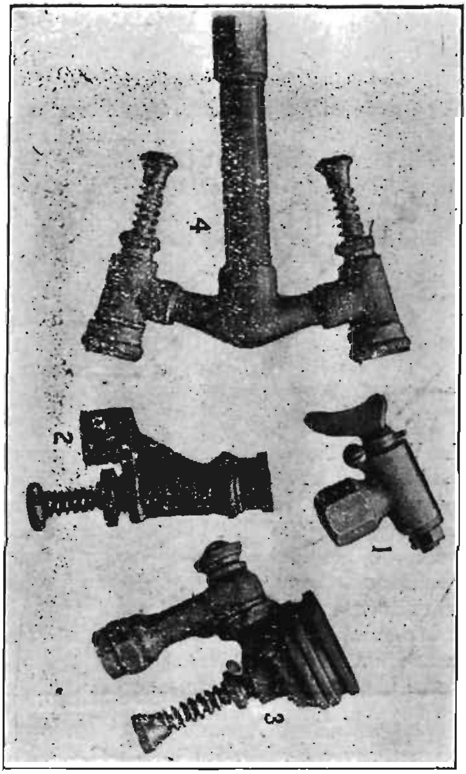

Fig. 17. Nozzles: 1, for Bordeaux Mixture; 2, 3 & 4, Types of Vermorel Nozzle.

parasites that may occur in the scale insects may have an opportunity to emerge and escape. The remaining central tuft of leaves at the top of the tree should be carefully examined and, if found to be infested with any considerable number of scale insects, it should be sprayed with one of the washes referred to above.

Nearly all the species of scale insects in the West Indies are controlled by natural enemies, which consist of parasitic and predaceous insects and parasitic fungi. Those mentioned as pests of the coco-nut are not known to be attacked by parasitic fungi to the same extent as are certain other species. There can be no doubt, however, that these pests are often kept well under control by natural enemies, and it is most likely that other insects such as minute internal parasites and the lady-bird and other species which devour the young and adult scales, are the most efficient of these natural checks. When it is seen that scale insects, white fly and mealy-bug present on their favourite food plants are unable to spread rapidly, although no artificial control measures are being employed, it is safe to conclude that they are being held in check by some natural agency. Should it be discovered that any of these species of scale is decreasing in numbers or is not increasing, in any locality, it is probable that the controlling agency could be transferred to other situations where the scales are increasing, by the simple process of carrying scale infested material from the former to the latter locality.

Biting Insects. In British Guiana and Trinidad, the caterpillars of a large butterfly, *Brassolis sophorae*, have been found to feed on the leaves of the coco-nut palm, and often cause serious injury to the trees and produce a decrease in the yield of nuts. An account of the appearance of the larvae and adult of this insect, and of its habit of feeding is contained in a report in the British Guiana *Gazette* for July 28, 1909. The caterpillars are about 2½ inches in length, when fully grown; they feed at night, and rest during the day in large nests which they construct by tying the leaflets of the coco-nut together, with silken threads spun for the purpose. Several hundred caterpillars may hide together in one nest. As the nests are very conspicuous, it is suggested that a satisfactory method of control may be found in cutting away the leaves to which the nests are attached, and destroying the larvae by

crushing or burning them. They might also be destroyed by the use of a spray consisting of a solution containing arsenate of lead. In the Panama Canal Zone, a closely related butterfly (*Brassolis isthmia*) has been reported as attacking coco-nuts in the same way as *B. sophorae*, in South America. The Panama species is, however, said to be controlled by a parasitic fly (*Experiment Station Record* of the United States Department of Agriculture, Vol. XX, p. 516).

BORING INSECTS. The palm weevil (*Rhynchophorus palmarum*) sometimes occurs as a serious pest of coco-nuts, while it is also known to attack several other species of palms and has recently been reported as a pest of sugar-cane

FIG. 18. THE PALM WEEVIL.

in Trinidad. (Fig. 18.) It has probably been much more abundant throughout the West Indian islands in past times than it is at the present day.

The adult is a large black weevil about $1\frac{1}{2}$ inches in length, provided with a long snout or proboscis. The larva is the large, whitish grub known in the West Indies and British Guiana as the gru-gru worm, probably on

account of the fact that it is often found in the stem of the gru-gru palm. The pupa is enclosed in a large cocoon made from the fibres of the plant in which the grub has developed. This cocoon is about 3 inches in length and about 1½ inches in diameter. (Fig. 18a.) The female weevil deposits eggs in the

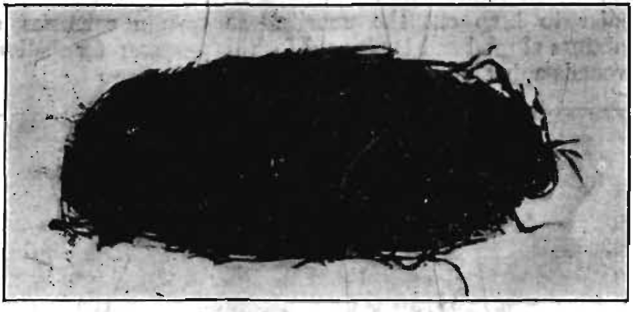

FIG. 18a. COCOON OF PALM WEEVIL.

tissues of the food plant. In the case of the coco-nut it is probable that wounds of all kinds afford favourable situations for this purpose. When the eggs hatch, the grubs bore through the tissues, and after becoming fully grown form pupae within the host plant. Trees that are dead or in a dying condition are more liable to attacks than are healthy ones. This fact suggests the remedial measures to be adopted. All dead or dying trees should be cut down as soon as they are discovered; if they are badly infested, they must be destroyed at once; if not, the trunks may be cut into lengths of 3 to 4 feet, and left on the ground as traps to attract the egg-laying female beetles. After a lapse of two or three months, when these pieces of palm trunk will have become infested with borers, they should be destroyed. The destruction of palm logs is a difficult matter; they are not easily burned, and in many localities it is not practicable to bury them. If they could be submerged in water for a

few weeks all the insects contained in them would be killed. It should also be borne in mind that coco-nut logs should not be used for building fences or bridges in the neighbourhood of coco-nut cultivations where the palm weevil is known to occur. Moreover, in these localities all wounds in the stems or buds of the coco-nut trees should be plugged at once, in order to keep out the weevils. In eastern countries a mixture of sand and tar is used for this purpose; for shallow wounds a dressing of tar will suffice.

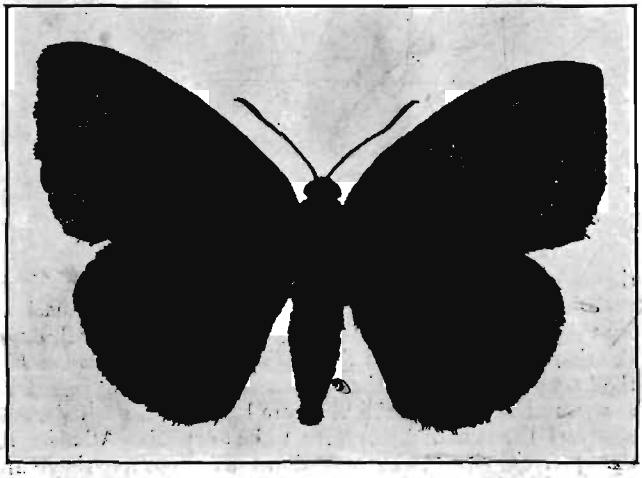

FIG. 19. CASTNIA LICUS (about natural size).

The giant moth borer of the sugar-cane (*Castnia licus*) is reported to attack coco-nuts in Trinidad, and a nearly related species (*C. daedalus*) is said to be a pest of the palm in Surinam. The manner in which these insects attack palms is not stated, but as *Castnia licus* is known as a borer in cane and bananas it is likely that it and its relative, *C. daedalus*, are also borers in the coco-nut palm.

FUNGUS DISEASES.

Like all other plants, especially when grown in large numbers in one place, coco-nuts are liable to diseases caused by parasitic vegetable organisms, fungi and bacteria. Four such diseases are now well known in the West Indies; while others may eventually be found to occur. Three of them are of considerable importance, while this is the case with the fourth only when the trees have become unhealthy from other causes. The diseases are: bud rot, root disease, stem bleeding disease and leaf disease. With the exception of root disease, they may be expected to appear on trees of all ages from four years upwards. To a casual observer, trees suffering from any of these diseases have much the same appearance. The leaves look yellow and sickly, and the outer ones often hang down round the trunk, while in some cases the tips of the leaflets may be broken and hang downwards. Such leaflets are dry and greyish in appearance, and are attached to unhealthy leaves. When trees are clearly in ill health and present the general appearance described above, the question arises as to what is the cause of the disease, and what is to be done to improve the condition of the trees and prevent the spread of infection. Further careful examination is required to determine these matters. When it has been ascertained that the appearance is not due to any of the insect pests described above, the trees should be examined for indications of the presence of any of the four fungoid diseases, a description of whose general symptoms and treatment follows.

BUD ROT. On carefully examining an unhealthy tree affected with bud rot, it is usually found that the young central leaves are standing upright and not unfolding as they should; soon afterwards they turn yellow and then brown, while the whole cabbage or central bud has an unhealthy appearance. Sometimes the drying up of the central shoots cannot be observed until many of the lower leaves have turned yellow or brown, while in a few instances,

the outer leaves are the first to appear unhealthy. The disease does not seem to follow any very definite sequence as regards the order in which the leaves are attacked, nor to be very constant in its point of origin, at any rate as it is known in the West Indies. After a time, the terminal bud falls over and the complete death of the tree follows slowly. Frequently, a ring of healthy-looking green leaves is left at the top, and these may continue green for some time after the bud has fallen. On cutting down a tree showing these symptoms, it is found that the bases of the young leaves and of the still undeveloped flower stalks, as well as all the soft tissues at the top of the stem, are affected by a soft brown rot and give off a most unpleasant smell. All the other portions of the tree, the roots and remainder of the stem, will be found to be quite healthy—a feature which distinguishes this disease from root disease or stem bleeding disease. Furthermore when the youngest visible leaf is observed to have fallen over and wilted, it is almost certain that the bud rot is present.

The cause of this disease is at present uncertain, though several authorities are inclined to attribute it to the presence of bacteria. Although the parasitic organism has not been definitely determined, there is but little doubt that the only safe course to pursue, when the disease appears in a plantation, is to destroy the infected trees as rapidly as possible. By the time that the outward symptoms make their appearance, the central bud is usually so badly decayed as to preclude the hope that the tree can be saved. In the present state of our knowledge, at any rate, it is far wiser to cut down the tops of infected trees and bury them deeply with lime, while at the same time the remainder of the trees should be burned. Other trees in their neighbourhood should be carefully watched for signs of the disease and treated in the same manner when it appears. If it spreads to any extent, trees in the neighbourhood of the infected area might be sprayed thoroughly with Bordeaux mixture. It is believed by some that placing salt inside the cabbage is a protection

against this disease, though no definite evidence on the subject is available.

Root Disease. This is practically confined to trees that have commenced to bear. Its first symptoms are often somewhat similar to those of bud rot, but the two may be distinguished on further examination. The first signs of its presence are shown by the leaves. These become wilted and then turn yellow, first at the tips and then all over the leaflets. Finally they dry up, blacken and hang down from the cabbage, often remaining a considerable time before they are shed. Frequently it is to be observed that the leaves do not hang down, but that the petioles or sheathing bases break across, leaving the sheathing portion on the trunk, while the expanded portion either falls to the ground or hangs down. Usually the outermost ring of leaves is the first to be affected, though often a middle ring becomes wilted and yellow first, while the leaves outside and inside it are green. After the yellowing of the leaves takes place, diseased trees shed most, if not all, of their nuts, irrespective of their age, while the flowers subsequently produced do not set. Finally, the terminal bud rots and falls over, and the tree dies. The earlier symptoms are exactly like those exhibited when trees are suffering from drought, and in fact are due to lack of water owing to the destruction of the roots. It may, however, be determined whether root disease is actually present or not by making an examination of the roots themselves and the first 2 or 3 feet of the stem. Such an examination quickly reveals a diseased and disorganized condition of the outer tissues of the roots, while, when the tree is cut into, it will be seen that a red discoloration, extending from the ground level for a distance of 2 or 3 feet upwards, is present in the stem. This may occur as a ring towards the outside, or as a general discoloration of the tissue near the centre of the stem. The death of the roots and the red discoloration of the stem are the two absolutely distinguishing signs of the condition.

The cause of the disease is at present uncertain; but the following remedial measures may be recommended. All infected trees should be cut down, their roots carefully dug up, and the whole burned. The soil from which the tree has been taken should be given a good dressing of lime and should be well forked over. As a further precaution, the infected area should be isolated by a trench 2 feet deep and 2 feet wide, the soil from this being thrown on to the infected land. When the trees have been dug out and burned, the land should be allowed to rest for a year, and then supplies should be planted. Attention should be paid to cultivation and drainage on any estate on which root disease makes its appearance.

Stem Bleeding Disease. The symptoms of this vary somewhat according to the age and nature of the trees attacked. In general, cracks appear in the bark, from which a brown viscid liquid oozes, that soon turns black and leaves a dark stain on the bark. On cutting away the cortex near the crack it is often found that the tissue has decayed and become soft and watery. In some cases the outer layer of tissue falls off, leaving a hole filled with fibres. In other cases spiral cylindrical hollows are formed, running up and down the stem; while in extreme cases the whole tree may be rendered hollow to within 2 or 3 feet of the terminal bud. This may occur even when only a few bleeding patches are visible externally. The disease does not necessarily cause the death of the tree, and its effect on the crop is usually small, at any rate for a time. Its importance lies principally in the fact that trees, weakened by the presence of the hollow spaces in their stems, are liable to be broken off in a strong wind. It is much more prevalent in wet weather than in dry. Stem bleeding is caused by a fungus, *Thielaviopsis paradoxa*, which is responsible for a rot of pine-apples and a decay of cane cuttings. Its spread in plant tissues appears to be dependent on the amount of sugar which they contain.

The remedial measures consist of cutting out the infected tissues and burning all chips. The operation is best performed with a chisel and mallet. Slanting wounds should be made, in order that water may run off them. When the diseased portions have been cut out, the surfaces of the tissues should be carefully burned with a torch to dry them, and the wound should then be dressed with tar.

LEAF DISEASE. Frequently leaves are observed which appear to be drooping and on which the tips of those leaflets remote from the stem are greyish in colour. The condition appears to spread gradually to the leaflets nearer the stem; when all the leaflets of the terminal 2 or 3 feet of the leaf have become badly diseased, this portion breaks down, and if the whole leaf is borne in a position between the vertical and the horizontal, the terminal portion remains hanging downwards. When the whole leaf occupies a position between the horizontal and the trunk of the tree, the terminal portion does not usually break off. An examination of the leaflets themselves reveals the facts that the tips and many parts of the edges are dry and dead, and that, on other parts, small yellowish spots, more or less regular in shape, occur scattered about the surface. These spots more frequently appear first on the under sides of the leaves; they extend in area, and often run into one another forming irregular blotches. As they increase in size, they change from a yellowish colour to a greyish-white in the centre, and are bordered by a distinct margin, usually of a deep greenish-brown colour. Finally, small greyish-black pustules are seen in the grey parts of the spots on the upper surface of the leaves. These are the fructifications of the causative fungus. When a large number of spots has collected on a leaf, it assumes a yellowish appearance and becomes grey and withered. It may remain hanging on the tree for some time, but it finally drops. As a result of the diseased condition of the leaves, the number of nuts borne on consecutive flower stalks diminishes, and finally no flowers set. In very

bad cases, the terminal bud is left standing alone and eventually this falls over and the tree dies.

Leaf disease is caused by a fungus known as *Pestalozzia palmarum*. It is found on several other host plants besides coco-nuts, including tea and seedlings of Para rubber plants.

The remedial measures consist firstly, of destroying the spores of the fungus and thus preventing its spread; and secondly, of improving the health of the trees by cultivation, drainage, and manuring. In order to destroy the spores of the fungus, all the outer, badly attacked leaves should be cut away and burned, while as in the case of the other diseases, dead trees should be destroyed. In bad cases it will probably be found useful to spray both infected trees and those which are healthy, in their neighbourhood, with Bordeaux mixture or some other fungicide. The solution should be applied in the same way as the insecticides, whose application was described in a previous section.

BORDEAUX MIXTURE.

Copper sulphate (bluestone)	6lb.
Unslaked lime	4 ,,
Water	50 gal.

The 6 lb. of bluestone is dissolved in 25 gallons of water in a wooden tub or barrel by tying it in a piece of sacking and hanging it in the water from a stick laid across the top of the barrel. The 4 lb. of freshly burnt unslaked lime is slowly slaked and made up to 25 gallons in another tub with water. Next the limewash and the solution of bluestone are slowly poured together into a third tub holding about 50 gallons. When the mixture is complete, stir and place therein a clean, bright knife blade for a minute. Remove the knife blade, and if it is still bright the Bordeaux mixture is safe, but if it appears reddish, more limewash must be added until the knife does not become

discoloured. The mixture should be stirred before use. Dry Bordeaux mixture can now be obtained ready-made from the United States, and can be used alone, or with Paris green.

These, then, are the principal fungoid diseases of coco-nuts at present known in the West Indies. All plantations should be carefully watched for the appearance of any or all of them; and when they appear, the measures already described should promptly be undertaken to control them. If any disease other than these makes its appearance, specimens of the infected parts should be sent to the local Agricultural Officer who will forward them to this Department, in order that steps may be taken to identify the causative organism, and measures recommended for controlling it.

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COMMERCIAL PRODUCTS.

The products obtained from the coco-nut are very numerous, but for commercial purposes, they may be considered under the heads of nuts, oil and copra, desiccated coco-nut and coir.

NUTS. Large numbers of coco-nuts are annually exported from Trinidad and Jamaica, principally to the United States of America, where they are sold in the markets of New York and Philadelphia. For this purpose, the nuts are deprived of their husks and are selected for size by means of a ring. This is 3¾ inches in diameter, and all nuts which can pass through it are rejected and used for the manufacture of copra, while those which will not pass through are packed and exported. Such a course is necessary as there is no demand for small nuts in the markets. Trinidad and Jamaica Select coco nuts have been quoted during the last year at $26 to $36 per thousand on the New York market, while culls have fetched from $18 to $20 per thousand. Although the exportation of coco-nuts themselves is an industry of considerable importance in the West Indies, yet this method of dealing with the produce fades into insignificance as compared with that involving the production of oil or of copra, from which oil is to be expressed, when the matter is regarded from the point of view of the world's commerce.

OIL AND COPRA. In past years the demand for coco-nut oil has been limited, as the supply was sufficient to meet the demand. The latter depended entirely, or almost entirely, on the employment of the oil in the manufacture of toilet soaps; it was unsuitable for most other purposes, because it was impossible to remove from it the flavour of coco-nut, and because it very easily became rancid. Thus, though the demand was constant, it was apparently limited. Recently, however, processes have been discovered by which this

product may be freed from its coco-nut flavour and at the same time rendered far less liable to become rancid. This has largely increased the number of purposes for which it can be employed; in consequence, the demand for oil and copra of good quality is far in excess of the supply, and the prices for these commodities are high and likely to remain so for some time, as there is at present no great tendency to increase largely the area planted in coco-nuts.

In order to show the wide range of uses to which coco-nut oil may be put, a few details may be given; these do not take into account the steady demand for it, occasioned by the manufacture of toilet soaps. In the first place, it is an excellent oil for cooking purposes, and attempts are being made to introduce it as a salad oil, for it is claimed to be superior to cotton seed oil for the purpose; it is also said to be a good substitute for cod liver oil in cases of illness such as phthisis, as it serves the same purposes and is far more palatable. It is also further employed in making vegetable butter, which has a large sale, and in preparing vegetable lard. This last is said to be as good as animal lard for cooking purposes and is far more wholesome, while it is also largely used in the preparation of ointments. Another interesting use to which the oil is put is in the preparation of the 'cream' in cream chocolates. Thus, with all these different methods of employment, some of which are only in the initial stages but have a most promising future, there is but little doubt that the demand for coco-nut oil will increase steadily for many years.

The oil is prepared from the white, hollow kernel of the coco-nut. The nuts themselves, when gathered from the trees, are first husked and then broken open with a cutlass, and the water in them is poured out. After this they are divided into several medium-sized pieces, from each of which the white kernel is extracted with a sharp knife. The kernel must next be dried. This may be done by spread-

ing the pieces on trays in the sun, when the process takes from five to ten days, according to circumstances. The trays are attached to shelter houses, such as are used for cacao, into which they can be run at night, or when rain threatens. Preferably, however, the pieces should be dried by hot air in a special drying house, when the operation can be completed in from twenty-four to thirty-six hours. Such a house must be provided with artificial heat, but at the same time, it is most important that it should be well ventilated. On an estate where the husks are not employed for the manufacture of fibre, these and the shells can be burned and will provide ample fuel for heating the drying house. The dried kernels form what is known as copra. Since the quality of the copra depends largely upon the quickness and thoroughness with which it is dried, it is really far preferable to employ artificial heat than sun heat for the purpose, as the former is more reliable. When dried, copra of good quality is quite white and possesses a pleasant smell; it breaks with a sharp, brittle fracture.

When the copra has been obtained, two courses may be followed: it may either be exported as it is, or it may be employed in the manufacture of oil, on the spot. Several of the most up-to date estates in Trinidad possess their own apparatus, while oil mills in the possession of private companies exist in several of the islands, and could probably be adapted for this purpose. To obtain an oil of good quality, good copra must be used. This is disintegrated to form a fine meal which is placed in bags, steamed and subjected to a pressure of 2 tons to the square inch, in hydraulic presses, until the flow of oil ceases. The oil may then be purified by the use of fuller's earth in its filtration.

The question as to whether it is cheaper to prepare copra alone for export or to manufacture oil, must be settled by each individual for himself. According to trials recently conducted in Ceylon, 10,000 small nuts weighing 1,284·5 lb.

gave 337·5 lb. of dry copra, so that ten nuts will give approximately $3\frac{1}{3}$ lb. of copra; about 50 per cent. of oil may be obtained from any given sample of copra by careful extraction. In considering the question, it should be borne in mind that the manufacture of oil requires some outlay on machinery, and that it must be carefully packed. It may, however, also be pointed out that the residue left over, after the oil has been expressed, forms a most valuable cattle food, or if not required for this purpose, an excellent manure for coco-nuts. It is known in the East as Poonac. In conclusion it may be stated that, recently, West Indian copra has been quoted at from £26 to £23 10*s.* per ton on the English market, while there seems but little likelihood that the price will fall below £17 per ton for good quality copra, for some time to come. Coco-nut oil is quoted in Trinidad at 90c. to 110c., or 3*s.* 9*d.* to 4*s.* 7*d.* per imperial gallon.

DESICCATED COCO-NUT. This is another form in which the kernel of the coco-nut may be exported. For this purpose, good ripe nuts are selected and opened, or shelled, by men provided with a hatchet or a small circular saw. The water inside the nut is poured away. The kernels are then passed on to women, who remove the rind with a sharp knife or spoke-shave. After this, the pure white kernels are washed and then placed in machines, by means of which they are either minced fine, or cut into chips or strips according to the machine used and the grade to be prepared. The product is next dried in a desiccator made for the purpose and finally, if in the form of mince, is sifted through sieves into three grades—Fine, Medium and Coarse. After this, it is ready for packing. In Ceylon, tea-chests lined with lead and paper are used for this purpose, and each is made to contain 130 lb. net of desiccated coco-nut.

The preparation of this product requires a considerable amount of manual labour and some initial outlay on machinery. At present it is not manufactured in the West